STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
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June 17, 2004

Dear Science Advisory Board Members:

RE: Discussion Materials for the June 22 Science Advisory Board Meeting

The purpose of this letter is to transmit additional materials to support the Board's review of Ecology's working definition of moderate levels of lead-contaminated soils. These include:

- Information on Measures to Reduce Exposure to Lead-Contaminated Soils: At the May 28 meeting, the Board recommended that Ecology focus on three main pathways of lead exposure: (1) incidental ingestion of soil and dust; (2) consumption of homegrown vegetables; and (3) inhalation of re-suspended soils and dust. The Board also requested that Ecology provide additional information on the relative importance of these three pathways and the effectiveness of various intervention measures designed to reduce lead exposure. Enclosure A was prepared in response to that request. Enclosure A includes a table with estimates on relative amounts of lead uptake predicted by the IEUBK model for the three pathways and estimates on the potential reductions in lead uptake that might occur as a result of various types of intervention measures.

- List of Questions on Lead-Contaminated Soils: At the January meeting, Ecology distributed a list of questions on lead-contaminated soils. During the subsequent two meetings, the Board has discussed and provided initial responses to many of those questions. Ecology has reviewed the results of those discussions and has prepared a list of remaining questions (Enclosure B) that are designed to focus on the key issues that have emerged from those earlier discussions.

If you have questions or comments regarding these materials, I can be reached at 360/407-6907.

Sincerely,

Dave Bradley
Toxics Cleanup Program

DB:cp

Enclosures

Enclosure A

Exposure Reduction Measures

Potential Impact on Lead Uptake Due to Various Exposure Reduction Measures for Residential Properties

High

Site-Specific Measures to Reduce Exposure Implemented Under MTCA or Other Authorities

Soil Concentrations = 500 mg/kg (based on Blood Lead Concentation = 15 ug/dL)

Moderate

Exposure Pathways	Pb Uptake (ug/day)	Actions to Reduce Exposure to Lead-Contaminated Soils	% Pathway Reduction (est)	Reduction in Pb Uptake ug/day
Soil/Dust Ingestion	14	**Assumption** = Soil and Indoor Dust each contribute 50% of uptake		
		* Education Intervention (Hand Washing + Maintain Good Nutrition)	0-40%	0 - 5.6
		* Indoor Dust Control (e.g. vacuuming, carpet cleaning, wet mopping)	20-45%	3.5 - 6.3
		* Soil treatment to reduce bioavailability (e.g. addition of phosphates)	10-40%	1.4 - 5.6
		* Clean soil, wood chips and/or pavement (with or w/o removal) + Maintain	50%	7
		* Cover/remove outdoor soils + indoor dust controls	70 - 100%	10 - 14.0
Consumption of Garden Vegetables	8	**Assumption** = Lead in plant tissue and lead in soils clinging to plants each contribute 50% of estimated uptake		
		* Education Intervention (Wash & Peel Garden Produce + Good Nutrition)	0 - 60%	0 - 4.8
		* Soil treatment to reduce plant uptake and bioavailability	20-40%	1.6 - 3.2
		* Soil Removal and/or Replacement (e.g. raised garden beds)	100%	8
Inhalation of Re-Suspended Soils	0.06			
		* Plant Grass/Water Grass and Bare Soils	50%	0.03
		* Clean Soils, Wood Chips and/or Pavement + Maintain Cover Material	100%	0.06
		* Remove Soils and Replace with Clean Soils	100%	0.06
Non-Soil Lead Exposure	2		0%	
Total Estimated Lead Uptake	24.4			

Soil Concentrations = 250 mg/kg (based on Blood Lead Concentration = 10 ug/dL)

Low

No Further Action to Address Human Health Risks Required Under MTCA and/or Provide Information Materials

Explanatory Notes

This table provides estimates of the potential impact on lead uptake resulting from various exposure reduction measures for soils with 250 – 500 mg/kg.

- **Exposure Pathways**: The table includes lead uptake estimates associated with soil/dust ingestion, consumption of garden vegetables grown in lead-contaminated soils, inhalation of re-suspended soils and non-soil lead exposure (e.g., lead in national food supply, drinking water, etc.). Lead uptake from non-soil lead exposure is assumed to be unaffected by measures to reduce exposure to lead-contaminated soils.
- **Pb Uptake (ug/day)**: Lead uptake resulting from exposure to lead containing 500 mg/kg was estimated using the Integrated Exposure Uptake Biokinetic (IEUBK) model.
- **Actions to Reduce Exposure to Lead-Contaminated Soils**: The table identifies several actions that people might take to reduce exposure to lead-contaminated soils. In a broad sense, the actions can be grouped into three main categories which vary in terms of their reliance on personal behavior changes.
    - Education Intervention: The most common strategy for reducing lead exposure is to provide educational materials to parents and children that provide advice on simple measures to reduce exposure (e.g., hand washing, wash/peel homegrown produce, dusting, etc.)
    - Interim Controls: This category of actions includes physical changes that can be made quickly and relatively inexpensively to reduce or eliminate exposure. Potential actions include planting grass, installing soil/wood chip covers, raised garden beds, etc. Such measures require some level of continued maintenance.
    - Cleanup Measures: This category of actions includes engineered controls that reduce or prevent exposure to lead-contaminated soils. Potential actions include soil removal and capping with pavement or large amounts of soil.
- **% Pathway Reduction (estimated)**: The table provides rough estimates on the extent to which lead uptake might be reduced following implementation of the various measures. The estimates are presented as a percentage of the lead uptake for that pathway. For example, indoor dust controls are estimated to result in a 20-45% reduction in the estimated lead uptake associated with soil/dust ingestion. This reflects two main assumptions: (1) half of the estimated daily lead uptake from this pathway (14 ug/day) is due to indoor dust exposure; and (2) the effectiveness of indoor dust controls varies from 40% (resident) to 90% (professional cleaning).

Reduction in Pb Uptake (ug/day): The table provides rough estimates on the potential reductions in lead uptake that might result from implementation of the various measures. For example, a 20-45% reduction in lead uptake from soil/dust ingestion (14 ug/day) corresponds to a potential reduction of 3.5 – 6.3 ug/day.

Enclosure B

Discussion Questions for June 22, 2004 Science Advisory Board Meeting

Upper End of the "Moderate" Range of Lead Soil Concentrations

Question: Does the Science Advisory Board agree that the methods and assumptions used by Ecology to define the upper end of the moderate range are scientifically defensible?

Ecology's Rationale: The upper end of the moderate range varies depending on whether a property is used as a residence (500 mg/kg), school/child care facility (700 mg/kg) or a park/ commercial facility (1000 mg/kg). Ecology's rationale for selecting these concentrations includes the following:

- Ecology's current policy is to define the upper end of the moderate soil concentration range at a level where it is unlikely (< 1-5%) that exposure will result in blood lead levels > 15 ug/dL.
    - The measures recommended by the Area Wide Soil Contamination Task Force for low-to-moderate levels of soil contamination are similar to the actions recommended by the Centers for Disease Control and Prevention (CDC) for children with blood lead concentrations between 10 and 20 ug/dL.
    - CDC recommends the following actions be taken when a child is found to have blood lead concentrations between 10 and 15 ug/dL and 15 and 20 ug/dL: (1) health agencies provide educational materials on health effects and exposure reduction measures to the child's parents; (2) the parents and/or child implement precautionary measures to reduce exposure; (3) referral to social services (if necessary); and, (4) the child should be retested after 3-6 months.
    - CDC also recommends that environmental investigations and remediation be implemented when a child's blood lead concentration persists above 15 ug/dL.
- Ecology believes that the IEUBK model is a sound method for identifying soil lead concentrations that are unlikely to result in blood lead concentrations > 15 ug/dL.
    - The IEUBK model reflects current scientific knowledge on how children are exposed to environmental lead and the physiological processes that determine blood lead concentrations.
    - Validation studies completed by EPA indicate that model does a reasonable job of predicting blood lead concentrations in children.
    - The IEUBK model is widely used by state & federal agencies.
- Ecology believes that the methods and assumptions incorporated into the IEUBK model generally reflect a health protective approach for dealing with uncertainty and variability.
- Ecology believes that (1) people can implement reasonable measures to reduce their (and their children's) exposure to lead-contaminated soils; and, (2) permanent exposure reduction measures that are less dependent upon child behavior can be integrated with ongoing community activities (e.g., school construction and maintenance, property development).

Lower End of the "Moderate" Range of Lead Soil Concentrations

Question: Does the Science Advisory Board agree that the methods and assumptions used by Ecology to define the lower end of the moderate range are scientifically defensible?

Ecology's Rationale: The lower end of the moderate range is equal to the current MTCA Method A soil cleanup level (250 mg/kg). Ecology's rationale for selecting this concentration to define the lower end of the moderate range includes the following:

- Ecology's current policy is to define the lower end of the moderate soil concentration range at a level equal to the MTCA Method A Soil Cleanup Level (250 mg/kg).
  - Ecology's current policy is to not require further actions under the MTCA to address human health risks where soil levels are less than 250 mg/kg (Method A Soil Cleanup Level).
  - The current Method A Soil Cleanup Level (250 mg/kg) represents a soil concentration that is unlikely (< 1-5%) to result in blood lead levels above 10 ug/dL.
  - The CDC currently defines elevated blood lead concentrations as > 10 ug/dL. Although recent studies indicate that a child may be adversely affected by lead exposures at blood lead concentrations < 10 ug/dL, the CDC has decided not to lower their level of concern.[1]

- Ecology believes that the IEUBK model is a sound method for identifying soil lead concentrations that are unlikely to result in blood lead concentrations > 10 ug/dL.
  - The IEUBK model reflects current scientific knowledge on how children are exposed to environmental lead and the physiological processes that determine blood lead concentrations.
  - Validation studies completed by EPA indicate that the model does a reasonable job of predicting blood lead concentrations in children.
  - The IEUBK model is widely used by state and federal agencies.

- Ecology believes that the methods and assumptions incorporated into the IEUBK model generally reflect a health protective approach for dealing with uncertainty and variability.

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[1]CDC provided three reasons for its decision not to lower the blood level of concern: (1) no effective clinical interventions are known to lower blood lead levels of children with levels less than 10 ug/dL or to reduce the risk for adverse developmental effects; (2) children cannot be accurately classified as having blood lead levels above or below a value less than 10 ug/dL because of the inaccuracy inherent in laboratory testing; and, (3) there is no evidence of a threshold below which adverse effects are not experienced. Thus, any decision to establish a new level of concern would be arbitrary and provide uncertain benefits.

Properties with Soil Concentrations Below 250 mg/kg

Question: Does the Science Advisory Board believe there is a sound scientific justification for providing information on ways to reduce lead exposure in situations where soil concentrations are below the MTCA cleanup level (i.e., < 250 mg/kg)?

Background: At the May 28, 2004, meeting, the Science Advisory Board noted there several studies where adverse health effects have been reported at blood lead concentrations < 10 ugdL. Given these studies and a soon-to-be-published scientific review prepared by a work group of the Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP), the Board expressed concerns about Ecology's use of a blood lead concentration of 10 ug/dL to distinguish between (1) properties that require some type of action; and, (2) properties that require no further action. The Board discussed two main approaches for addressing this concern:

- Use a lower soil concentration to define the lower end of the moderate range; or
- Provide information on exposure reduction measures to owners/residents in areas where soil concentrations are less than 250 mg/kg.

At the May 28 meeting, the Board and members of the audience identified several scientific, policy and feasibility considerations that argue for and against providing information on exposure reduction measures where soil concentrations are below 250 mg/kg.

Arguments for Providing Information on Exposure Reduction

- Recent studies indicate that children may be adversely affected where exposure levels result in blood lead concentrations < 10 ug/dL. Available scientific evidence does not provide a sufficient basis for identifying a threshold below which adverse health effects are not expected.
- CDC has concluded there are no effective clinical interventions that are known to lower blood levels for children with blood lead concentrations < 10 ug/dL. The lack of effective intervention measures emphasizes the importance of primary prevention measures.
- People can implement measures to prevent exposure to elevated levels of lead in soils. However, awareness and information are necessary prerequisites for taking such steps.

Arguments Against Providing Information on Exposure Reduction

- The ACCLPP work group concluded that blood lead levels < 10 ug/dL are associated with several types of adverse health effects. However, the work group noted there are still questions on whether that association is causal. The work group concluded that "...the weight of evidence favors, and does not refute, the interpretation that these associations are, at least in part, causal".
- The CDC has decided not to lower its definition of elevated blood lead levels at this time.[2]
- Increased educational efforts will increase costs of responding to lead-contaminated soils and may dilute resources for responding to situations with high lead concentrations.

[2] See footnote #1 on previous page.

Protection of Adults and Older Children

Question: Does the Science Advisory Board agree that it is scientifically defensible to conclude that levels protective of young children also protect older children and adults?

Ecology's Rationale: One of the assumptions underlying Ecology's working definition for moderate levels of lead in soils is that levels that are protective of young children also protect older children and adults. Ecology's rationale for this assumption includes the following:

- Studies indicate that younger children (less than 36 months) are more susceptible to lead exposure.
    - Lead is a neurotoxin, and the developing nervous system is much more vulnerable to lead's toxic effects than the mature brain.
    - Young children have been found to absorb lead via the gastrointestinal tract more efficiently (50% relative absorption) than adults (@ 10-15% absorption).
    - A greater proportion of lead in the blood stream gains access to the brain of children (particularly children < 5 years of age) than adults.
    - Young children generally come into greater contact with soil and dust (per unit of body weight) than adults and older children.
- Soil concentrations identified using EPA Adult Lead Model are based on neurological effects in the developing fetus and are considered to be protective for other types of health effects in adults (e.g., hypertension).
- Health risks associated with adult exposures are generally lower than estimated health risks associated with child exposures. For example:
    - The IEUBK model predicts that it is unlikely (< 1-5%) that blood lead concentrations will exceed 10 ug/dL when young children are exposed to soil concentrations of 250 mg/kg.
    - The EPA Adult Lead Model predicts that it is unlikely (< 1-5%) that blood lead concentrations in the developing fetus will exceed 10 ug/dL when an adult is exposed to soil concentrations of 400 mg/kg.

Protection of Ground Water

Question: Does the Science Advisory Board agree that it is scientifically defensible to conclude that surface soil lead concentrations below 1000 mg/kg are unlikely to significantly impact ground water?

Ecology's Rationale: One of the assumptions underlying Ecology's working definition for moderate levels of lead in soils is that surface soil lead concentrations that are below 1000 mg/kg are unlikely to significantly impact ground water. Ecology's rationale for this assumption includes the following:

- Soil studies in orchard areas where lead concentrations were measured at several depth intervals indicate that lead is fairly immobile in soils. Elevated levels of lead in soils were limited to near surface soils (the upper 18-24 inches).

- Ecology did not observe elevated lead concentrations in ground water monitoring wells in the Gleed area of Yakima County which includes a large number of current and historic orchards. [The study team did not collect soil samples from the Gleed area.]

- Soil studies in areas adjacent to former smelter sites in Western Washington where lead concentrations were measured at several depth intervals indicate that lead is fairly immobile in soils. As in studies conducted in Central/Eastern Washington, elevated levels of lead in soils generally were limited to near-surface soils (the upper 18-24 inches).

- In 1998, the Science Advisory Board's Fate and Transport Subcommittee agreed with Ecology's conclusions that soil lead concentrations below 3000 mg/kg were unlikely to significantly impact ground water. Ecology's conclusions were based on the results of fate and transport modeling conducted using standard EPA ground water models.

Ecology is in the process of compiling ground water data from cleanup sites in areas impacted by emissions from the Ruston smelter.

Future Information Collection and Review

Question: Given available information, where does the SAB recommend that Ecology focus future information collection and review?

Potential Information Collection and Evaluation Recommendations Identified in Earlier Discussions: The Science Advisory Board has identified and discussed several information and evaluation needs during their review of Ecology's working definition for moderate levels of lead in soils. Based on a review of the summaries from previous meetings, potential information collection or evaluation needs identified by the Board include the following:

- Collect and evaluate information on soil lead concentrations along roads in Washington.
- Collect and evaluate information on the variability in blood lead concentrations in Washington children and the various risk factors that influence blood lead concentrations.
- Collect and evaluate information on soil lead concentrations in Washington in order to better characterize the variability in lead concentrations, and use that information when designing property-specific sampling efforts.
- Collect and evaluate information on lead concentrations in vegetables grown in Washington.
- Collect and evaluate information on the relationship between soil pH levels and other factors that might influence the potential for lead in surface soils to migrate into underlying ground water aquifers.
- Review, evaluate, and, as appropriate, revise the Method A soil cleanup level for lead based on scientific information on adverse health effects at blood lead concentrations below 10 ug/dL.